

APPLICATION OF LEAN MANUFACTURING IN STEEL INDUSTRIES BY MANAGING TOTAL QUALITY MANAGEMENT

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ABSTRACT

Lean manufacturing is a technique employed to increase the value of a product by eliminating wastes and lead time. Now a day's most of the waste generating in the steel plant is in the form of rework which lean considers it as its wastes. In this paper authors tried to identify the wastes occurring in the various departments of the steel plants and then analyzed the causes and sub-causes of the wastes with the help of fishbone diagram, and the suitable remedies are being provided.

KEYWORDS: Sub-Causes, Streamlining Process, Automation, Flexible Work Force and Creative Things

INTRODUCTION

Lean Manufacturing is a technique employed in various industries in order to improve the values of their products primarily emphasizing on eliminating non-value adding activities like wastes and lead time. A measurement of the worth of a product or service by a customer, based on its usefulness in satisfying a customer need is the value of a product. It is something that the customer is willing to pay for.

It is not the matter of concern for customers that which method is applied and what quantity of resources are utilized and how much wastes are generated during production. So Lean focuses on reduction of these non-value adding activities to produce a good quality product in lesser time and generating minimum wastes. There are basically two types of wastes generated during production of any product, they are avoidable and unavoidable wastes. Avoidable wastes are those which can be eliminated and unavoidable are those which can be minimized but can't be completely vanished off. Lean concerns with elimination of wastes instead of just reducing in some amount. [3]

The basic principles of Lean Manufacturing deals with

- Increasing value of the product
- Streamlining process
- Elimination of MUDA (waste)
- Cost reduction

There are various tools and techniques by which Lean runs smoothly, they are JIT (Just-In-Time), automation, flexible workforce and creative thinking. There are other fundamental tools like VSM (Value Stream Mapping), Kaizen (mistake proofing mechanism), CONWIP (Constant Work In Progress) and 5S.

Wastes are activities that adds cost or time but does not add value, consuming more resources (time, money, space etc.) that are necessary to produce the goods or services that the customer wants. Lean focuses on seven wastes, they are:

Table 1

Wastes	Description
Waiting	Waiting for job to be done.
Unnecessary Motion	Movement of any resources (people, part or machine) without any cause.
Over Processing	Processing beyond customer segment under utility.
Excess Inventory	Raw material, finished product that has tied capital to it.
Unnecessary Transport	Any unnecessary transportation of product, raw material or people during any process.
Over Production	Produce more than the requirement.
Rework	Repeating the manufacturing procedure due to some defects.

The main work strategy opted for process improvement is by applying Lean principles in material handling in steel plant. The main work strategy opted for process improvement is by applying Lean principles in material handling in steel plant. The work is basically based on eliminating wastes that are generating in steel plant in the form of rework.

LITERATURE REVIEW

VSM (Value Stream Mapping)

Value stream mapping (VSM) is an end to end view of all the activity in a product or service flow. It enhances visualization of any process and identifies waste in each step of the process. This is simply a drawing that makes the flow of material and information visible.

With the help of VSM lean is applied in a Health care sector of Libya and achieved a great extent of success in minimizing waste of time, reduction in lead time achieved, patient serving capacity increased, improvement in capacity of health care sector achieved by applying lean.[3]

Lean manufacturing system is applied in civil construction system for problems like long lead times, too many material handling, inventory etc. With the tool like JIT (just in time), automation, flexible work force and creative things and apply methodology of VSM, 5S and following TPS. CONWIP (Constant Work In Progress, Kaizen mistakes proofing mechanism the performance of construction System is improved.[1]

5S Implementation

5S is applied for lean manufacturing and implemented in beverage production system. To increase efficiency in micro level waterfall chart are used for improvement depiction. 5S include the following steps to be followed:

Sort, Set in order, Shine, Standardize, Sustain [2]

TQM (Total Quality Management)

It is defined as the process of sequential development of a product in terms of its quality. It is an approach in which all the employees work together for the improvement in product, process and their working environment. Its main aim is satisfaction of the customers. [4]

METHODOLOGY

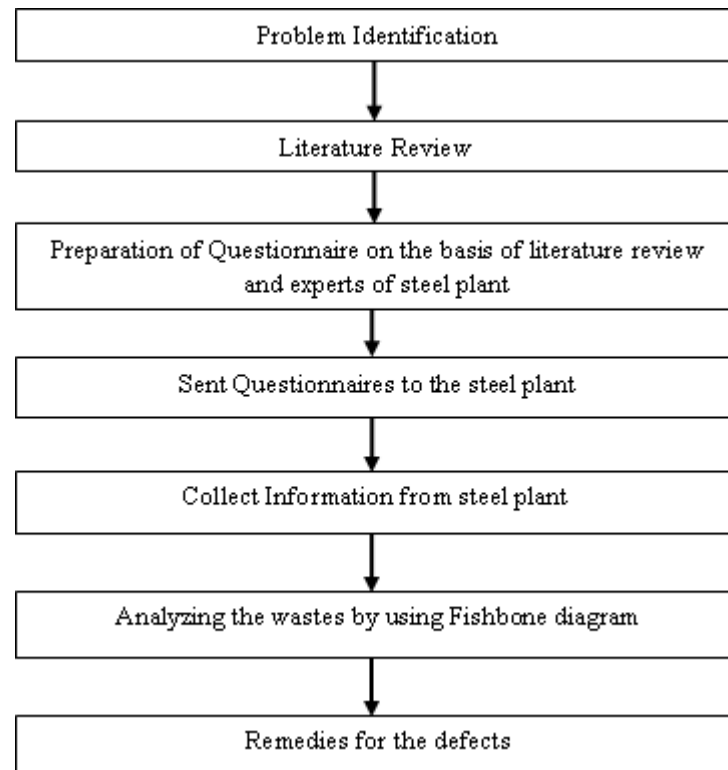


Figure 1

The questionnaires are the series of questions prepared for asking the details of each and every process such as the time consumed in the process, the amount of work done, the wastes generated etc.

Firstly the questionnaires are sent to the each and every department of the steel plant. Secondly the information collected by the help of questionnaires is properly arranged in terms of their affectivity to the final product for each department.

As discussed earlier there are basically seven types of wastes which can be eliminated with help of Lean principles, then the major waste is found which is more prone in steel plant. After getting the information from the plant with help of questionnaires, the major type of waste found out to be rework. The wastes are analyzed by drawing fishbone diagram which explains the causes and sub-causes of the wastes generating then the authors tried to eliminate the wastes generating by giving some remedies.

RESULTS

The wastes found out by the questionnaires sent to the plant in the different departments are listed below

Table 2

Shop Name	Production (Per Month)	Waste (Per Month)	Percentage Waste
Rail Mill	1.5 MT	0.15 MT	(8-12)%
Billet & Bloom Mill	2.5 MT	0.05 MT	(1-3)%
Plate Mill	3 MT	0.25MT	(5-10)%
Stripper Yard	2.1 MT	0.4 MT	(15-30) %

This table shows the departments which contributes the maximum amount of wastes generating in the plant. From the above table it can be concluded that the maximum wastes occurring in steel plant is in Stripper yard.

Now the types of wastes generating in Stripper yard are described. Mainly there are two types of wastes generated in this shop and the further classification of the wastes is shown below:

Physical Waste

It contributes approximately 10% to the total waste generating in this shop. It arises due to:

- Improper pouring of metal.
- Improper cross-section to the height ratio.
- Carelessness of operator.

Chemical Waste

It contributes about 90% to the total waste. It occurs due to:

- Sudden cooling of the material.
- Sudden heating of the material.
- Difference in concentration of materials.

Fishbone Diagram

The fishbone diagram is prepared which clearly represent the causes and sub causes of the problems occurring. Purpose of preparing fishbone diagram for the problems is to check out the available working conditions with the remedies and hence achieve an optimum working condition so as to achieve best possible output.

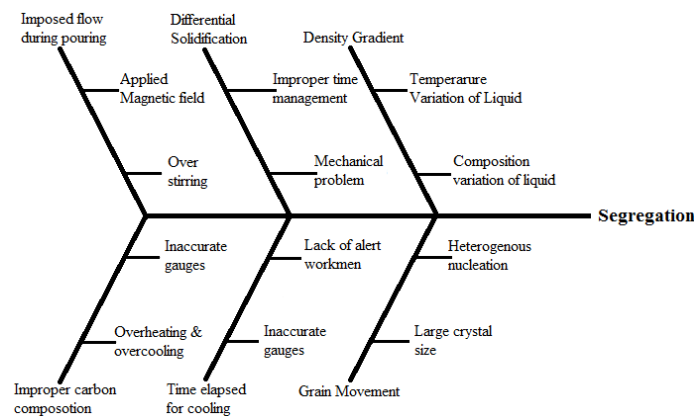


Figure 2

Causes of Segregation

- **Density Gradient**- One of the most frequent cause of segregation is convective flow of ingot element due to density gradient within it. Density gradient is mainly generated due to variation of temperature in liquid metal. It can also be generated due to variation of composition of liquid metal.
- **Grain Movement**- Segregation can also occur due to the movement of equiaxed grains or solid fragments which are generally impelled by heterogeneous nucleation.

- **Imposed Flow during Pouring-** Another possible reason for Segregation can be the flow of metal forcibly imposed into the ladle during pouring. This is originated due to the formation of magnetic field due to whirl formation. Other reasons can be over stirring and over rotation.
- **Improper Carbon Composition-** The carbon composition which doesn't matches with the standard carbon composition of steel also causes segregation. Carbon composition is generally hindered due to overheating or overcooling of the liquid metal. Inaccurate gauges used to measure composition for inspection may be the possible reason as well.
- **Differential Solidification-** It is a phenomenon in which the liquid metal attains ambient temperature layer by layer and, so the overall condition and structural state of the layers attains variation and hence causes segregation. Differential solidification generally takes place due to improper time management or in-alertness, or either it can be due to mechanical problem in the service.
- **Time Elapsed for Cooling-** Lack of alert workmen generally lead to waste of time and hence this severe problem is generated while cooling.

Fishbone Diagram for Cracks

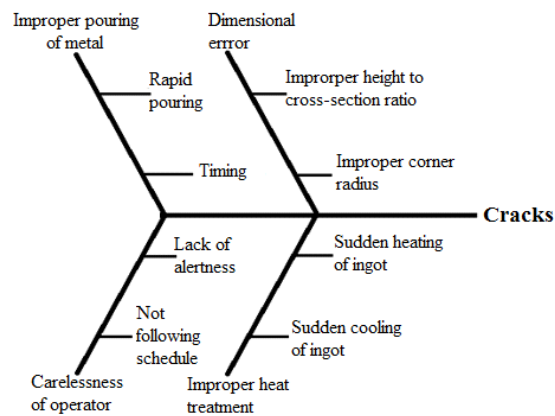


Figure 3

Causes of Cracks

- **Improper Pouring of Metal-** One of the most frequent reason for the occurrence of cracks in ingot surfaces is improper pouring of metal into the ingot moulds. It takes place when the liquid metal is rapidly poured into the mould or when poured with improper timing.
- **Dimensional Error-** Cracks also crop up when the ingot's dimension is not perfectly set. i.e. When the height to cross-sectional area ratio is improper cracks occur in ingot's surface. When the corner radius is not according to the height of ingots, then also cracks can take place.
- **Carelessness of Operator-** Lack of alert workmen has been seen as one of the frequent reasons for the occurrence of a lot of unwanted problems. They generally do not follow the mandatory instructions due to their own laziness and thus it leads to problems e.g. like cracks in ingots.
- **Improper Heat Treatment-** When cracks occur in ingots a lot of times it has been experienced that it is occurred because it is not treated properly with heat. When it attains a sudden change of temperature whether it is sudden heating or sudden cooling cracks take place.

- There are other wastes that are generating are given below with their causes and sub-causes:
- **Pipe Formation:** It can be defined as the cavity formed by the volumetric contraction during solidification. It decreases the ingot yield. It arises due to improper pouring of molten metal.
- **Blow Holes:** It occurs due to entrapment of gases evolved during solidification of steel.
- **Double Pouring:** It can be defined as the pouring of molten metal in the mould step by step keeping some time gap between two pouring. An oxidized layer is formed in this process and it can also leads to lappines. It arises due to low teeming temperature and also due to pouring at very slow speed.

Remedies

The ingots having defects are treated as waste in the plant and there are some ways in which these ingots can be reused. They are send to reheating and then they are mixed with the molten metal.

The one way of reusing the ingots is:

- Reusing the ingot in the same plant.

A better way is one that is to use the ingot in the same plant by sending the ingot for cutting where the part of ingot not having defect is separated from the part having defect, and then the part without defect can be utilized as billet in other mills, where the required size is less than that of ingot.

In this way the need of rework is eliminated which is required as per the process, in this way the Lean principle is implemented in the plant, as Lean considers rework as one of its wastes.

There are also some other ways of removing these defects are:

- Prolonged soaking of ingots.
- Pouring little more metal after partial solidification.
- One should also focus on keeping the dimension of the ingot as per standard to avoid these defects.
- The pouring of metal is to be done carefully by not pouring the metal rapidly or too slow.
- While cooling, the ingots should be cooled at adequate rate in order to avoid cracks.

There are also some causes of defects that are related to time, that are differential solidification and time elapsed for cooling. During differential solidification time management is most important issue, because steel is a mixture of metal which have different rates of solidification or cooling, that's why segregation took place. In order to avoid differential solidification one should mix the materials required in the production of steel at proper time and it should mix completely with other metals.

In order to eliminate the defect taking place due to time elapsed for cooling, there should be strict supervision on the time while cooling of molten metal take place, there should not be more cooling or less cooling.

The reduction in wastes in stripper yard is given below:

Table 3

Shop Name	Production	Wastes	Percentage Waste	Reduction in Waste	Percentage Reduction
Stripper Yard	2.1 MT	0.4 MT	(15-30) %	0.1 MT	(4-7) %

CONCLUSIONS

With this study the authors found out the wastes generating in steel plant, and it is found that the most prone zone is stripper yard of the steel plant and mostly the wastes are generated by segregation. This cause is analyzed and the suitable remedies are being provided. The above work shows that how the rework can be reduced and lean principles can be implemented in the steel plant.

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